Simulating North American precipitation and soil moisture of May and June 2003 with NASA/NCAR fvGCM with two cloud schemes: CCM3 and McRAS

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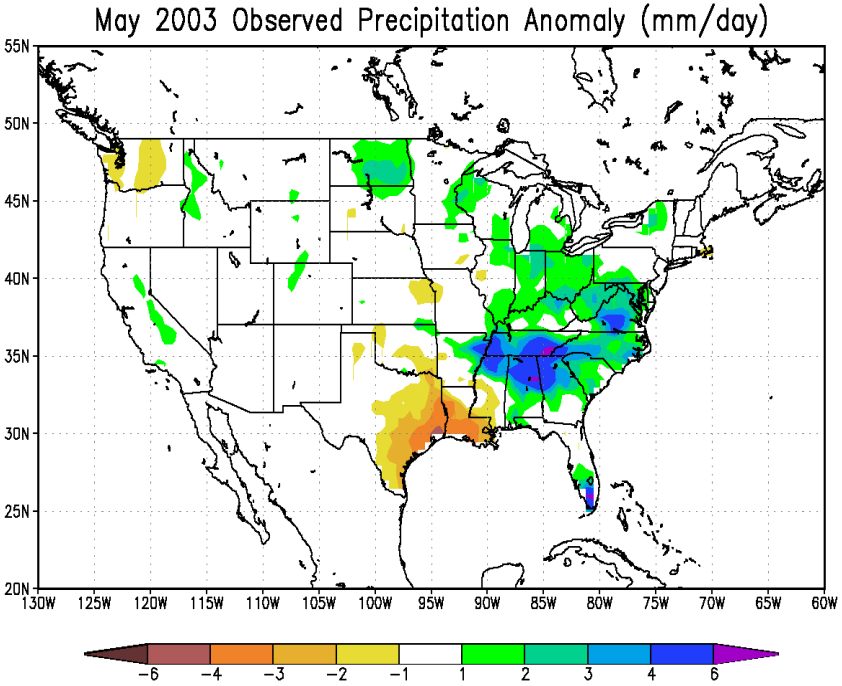
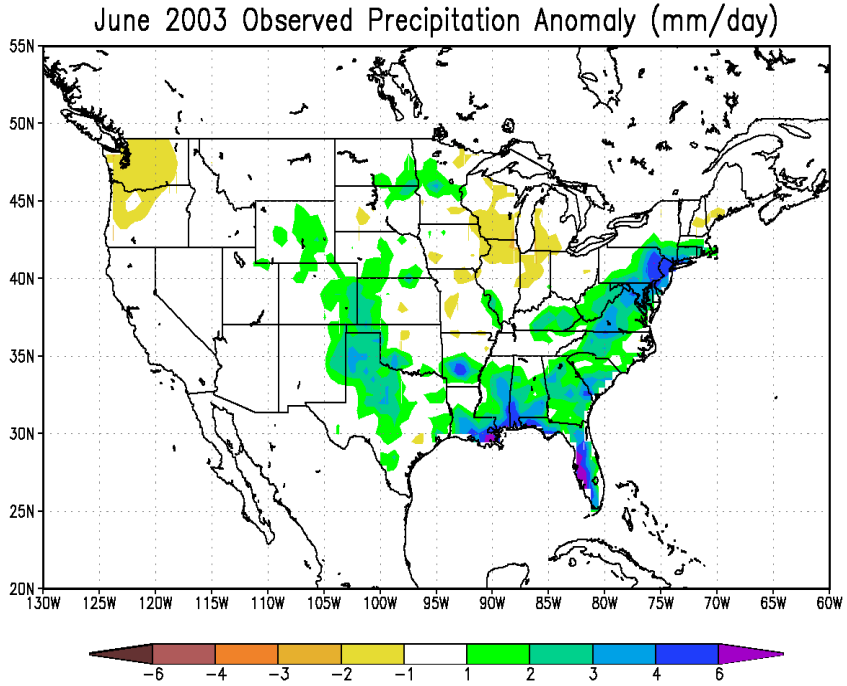
Goals of the study

- Evaluate the McRAS cloud scheme in the NASA/NCAR fvGCM
- McRAS has been shown in several papers to perform well in climate simulations as well as in tests in a single-column model
- As objectively as possible, test McRAS in a forecast mode in the GCM, as clouds are dependent on weather and its dynamics

May & June Precipitation anomaly





May 2003 June 2003

2003 observations from CPC; Climatology from GPCP

Model Description

- fvGCM uses finite-volume dynamical core
- Clouds and radiation from NCAR CCM3
- McRAS cloud scheme also used in fvGCM
  - Based on Relaxed Arakawa-Schubert
  - Prognostic cloud liquid water
- Chou *et al.* radiation used with McRAS
- Model run at 0.5 x 0.625 with 32 levels
- 10-day forecast run daily at NASA Goddard

Model References

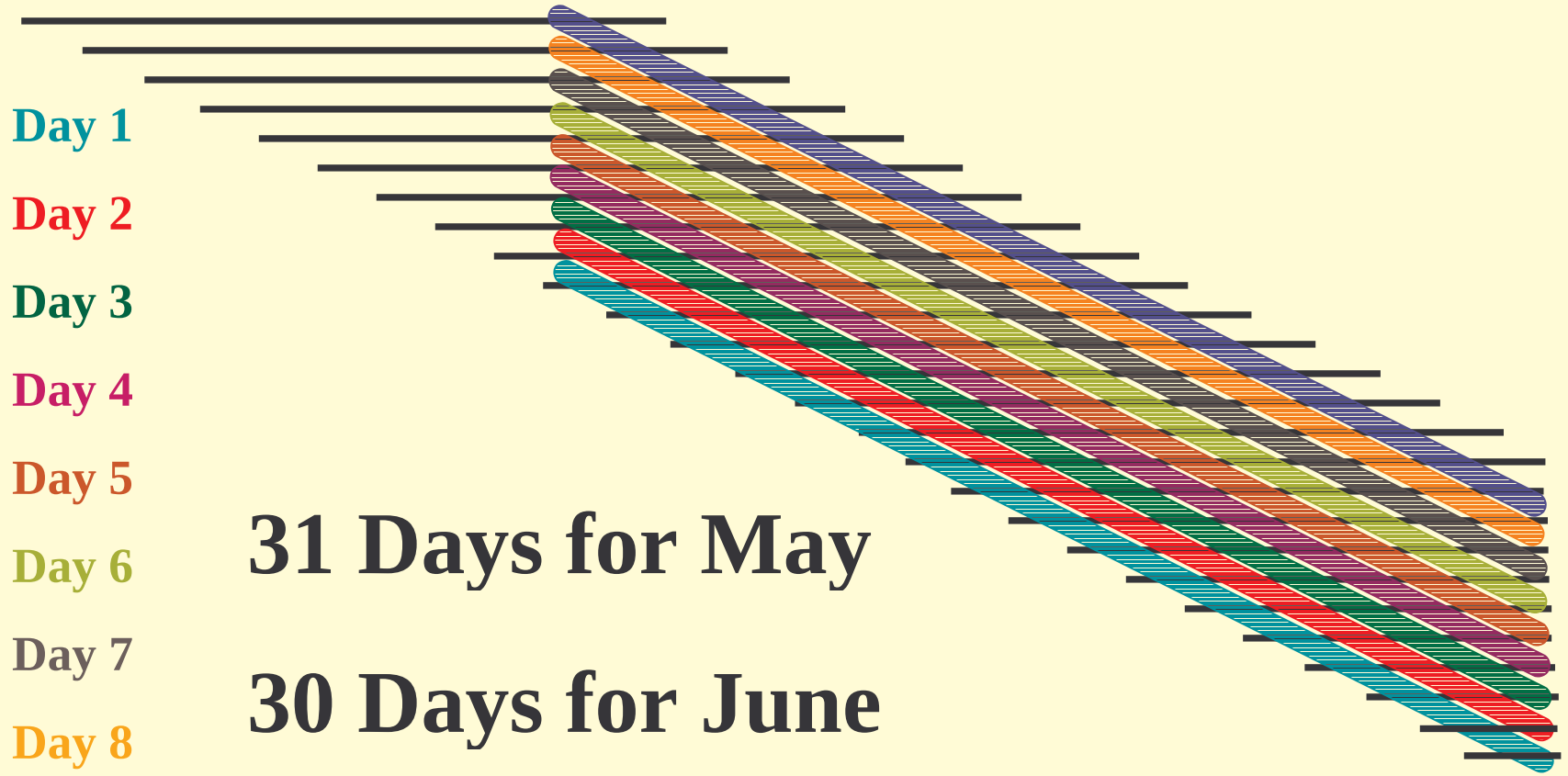
- fvGCM:
  - finite-volume (Lin & Rood, 1996, *J. Climate*)
  - Model physics from NCAR CCM3 (Hurrell *et al.*, 1998, *J. Climate*)
  - Convection (Zhang & McFarlane, 1995, *Atmos.-Ocean.)*
  - Community Land Model
- McRAS (Sud & Walker, 1999a&b, *J. Climate*):
  - Relaxed Arakawa-Schubert (Moorthi & Suarez, 1992, *Mon. Wea. Rev.*)
  - Cloud-radiative forcing (McFarquhar, 2001, *QJMRS*)
- Chou *et al.* radiation (1998 & 1999, *J. Climate*)

Experiment Design

- Initial soil moistures from spun-up CLM
- Daily averages made from 12Z to 12Z
- Monthly averages were made from average of daily values based on start date of the simulation and the lead-time of forecast
- In this way, monthly “Day 1” to “Day 9” lead-time forecasts were produced for both months and cloud schemes
- Can be considered an ensemble of forecasts

Experiment Representation

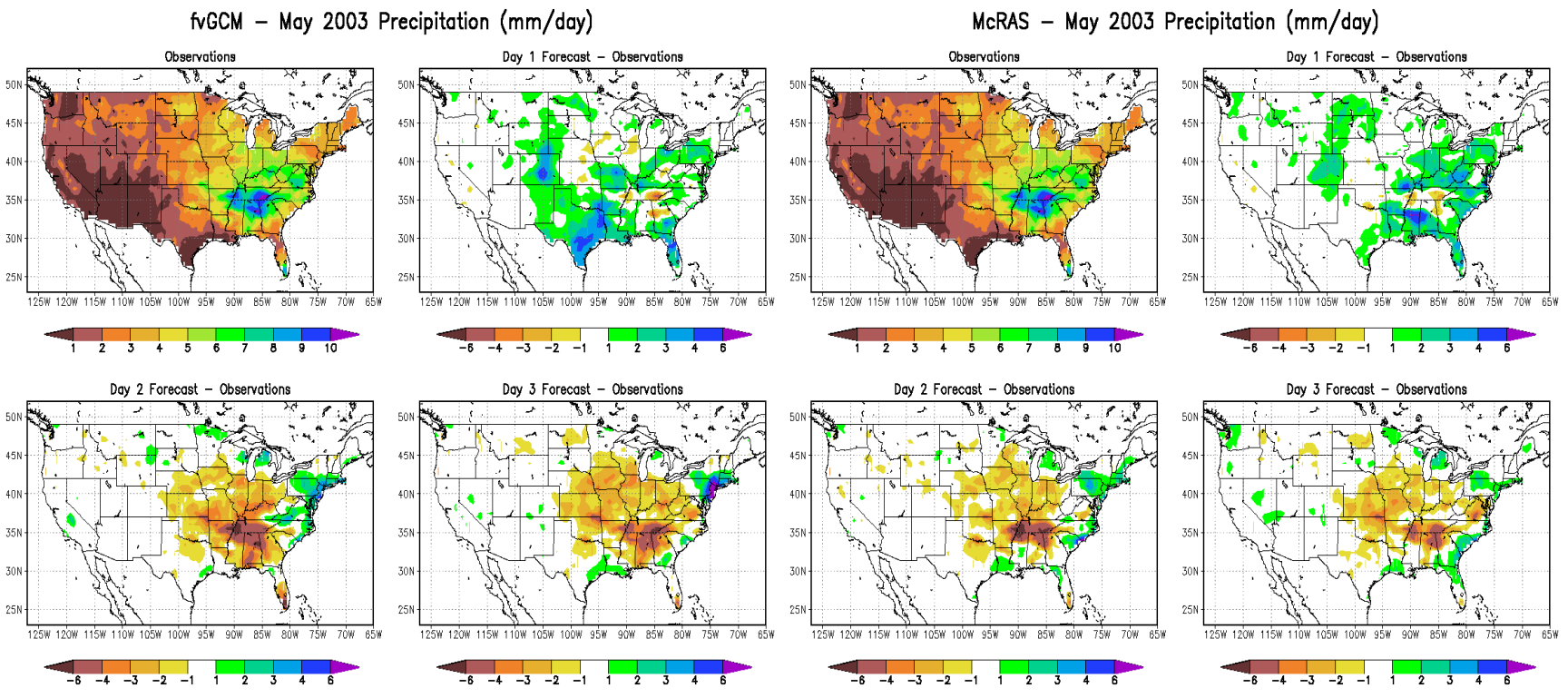
A22 A23 A24 A25 A26 A27 A28 A29 A30 M01 M02 M03 M04 M05 M06 M07 M08 M09 M10 M11 M12 M13 … … … M31



31 Days for May

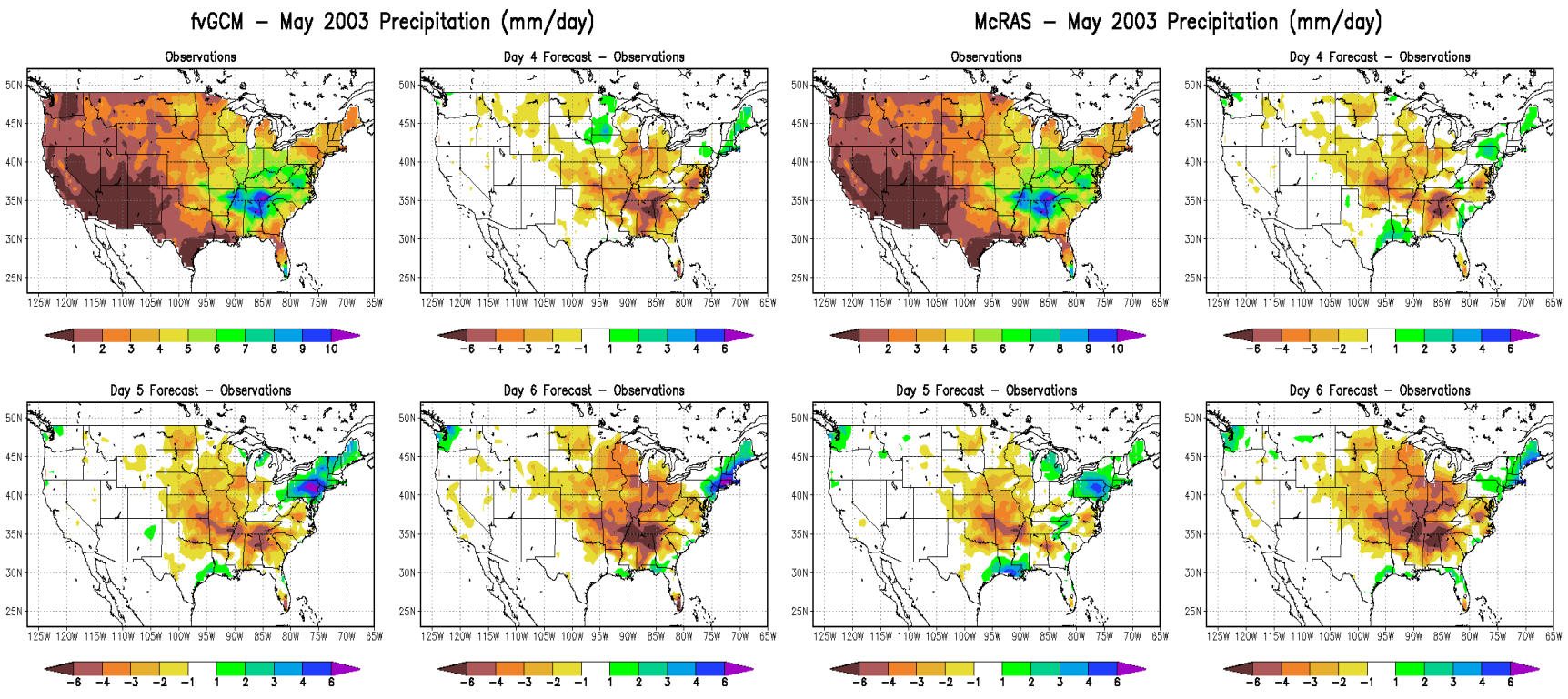
30 Days for June

May Precipitation: Day 1-3 forecast



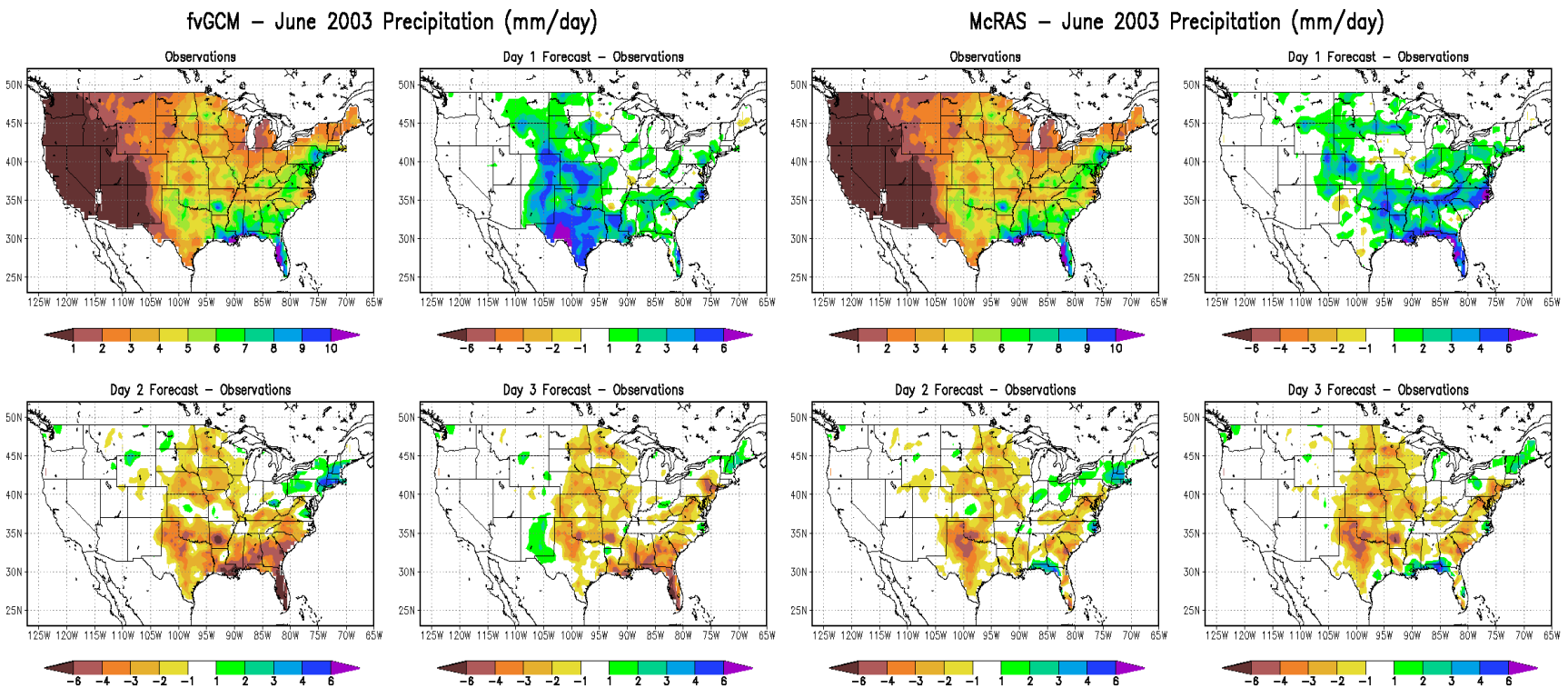
fvGCM fvGCM w/ McRAS

May Precipitation: Day 4-6 forecast



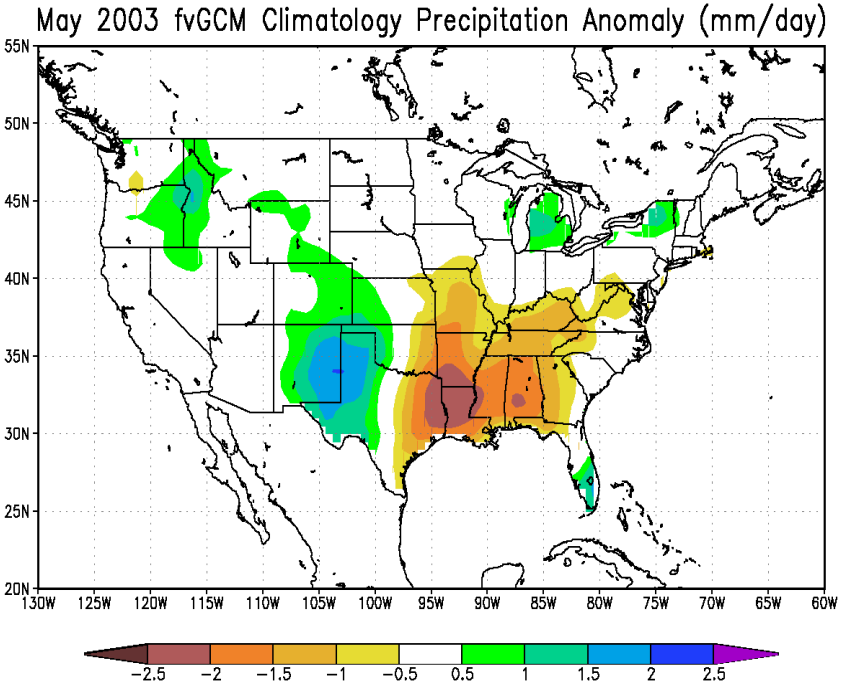
fvGCM fvGCM w/ McRAS

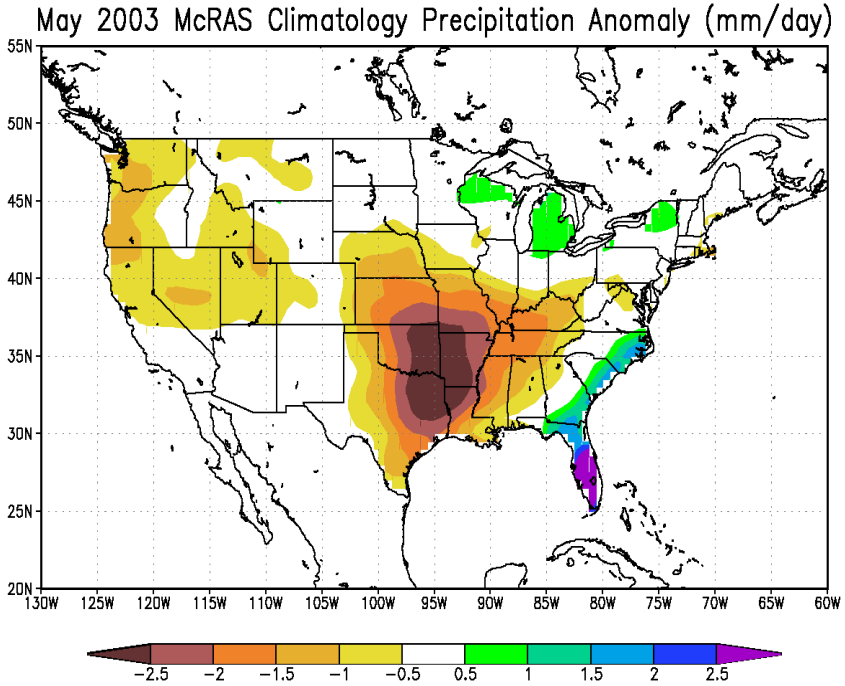
June Precipitation: Day 1-3 forecast



fvGCM fvGCM w/ McRAS

May Climatology Precipitation anomaly





fvGCM fvGCM w/ McRAS

Model from 17-year 1x1.25 run; Observed from GPCP

Anomaly Correlation (AC)

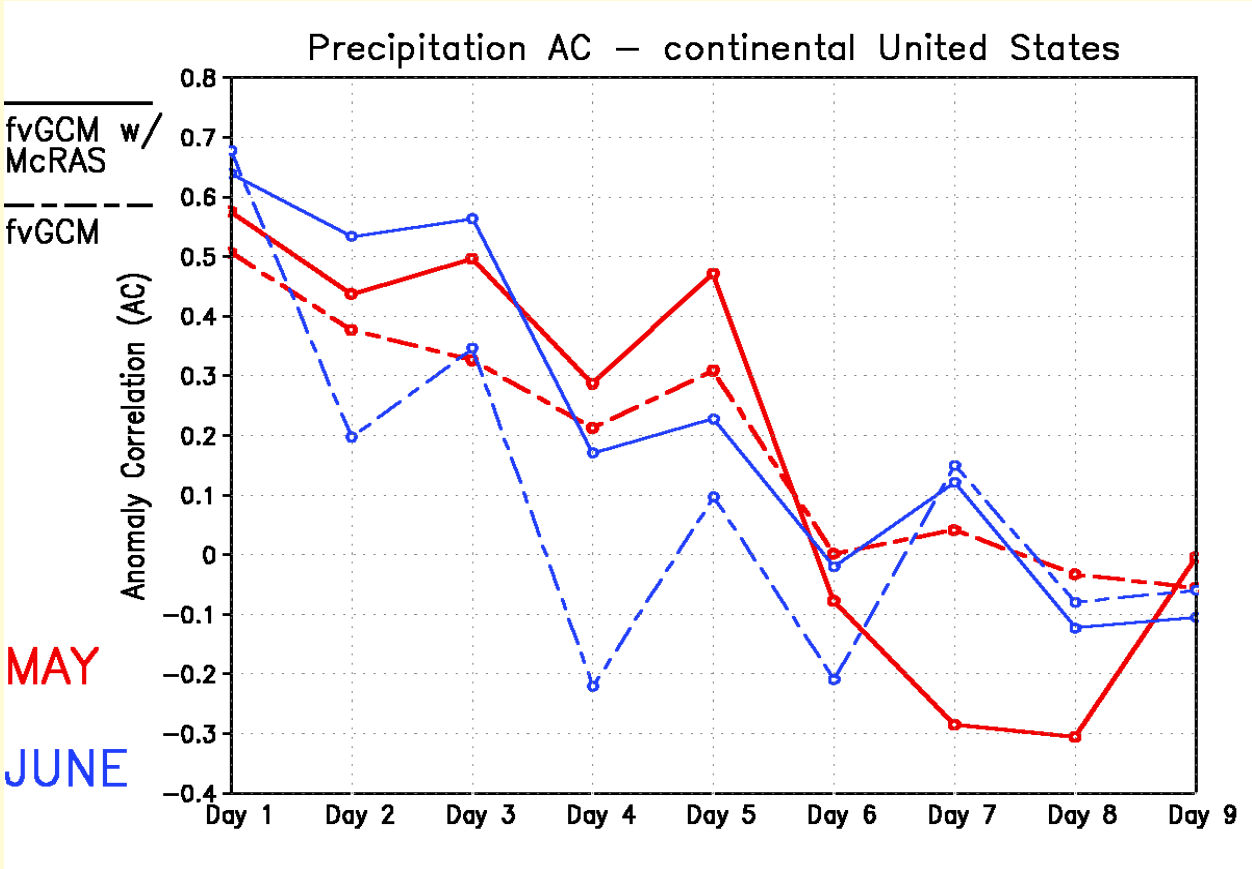
$$AC_{\psi} = \frac{\sum_{i,j}\left[\left(\psi_{O_{i,j}} - \overline{\psi_{O_{i,j}}}\right)\left(\psi_{M_{i,j}} - \overline{\psi_{M_{i,j}}}\right)\right]}{\sigma_O \sigma_M}$$

O = Observations; M = Model; σ = Standard Deviation

Overbar represents climatological values

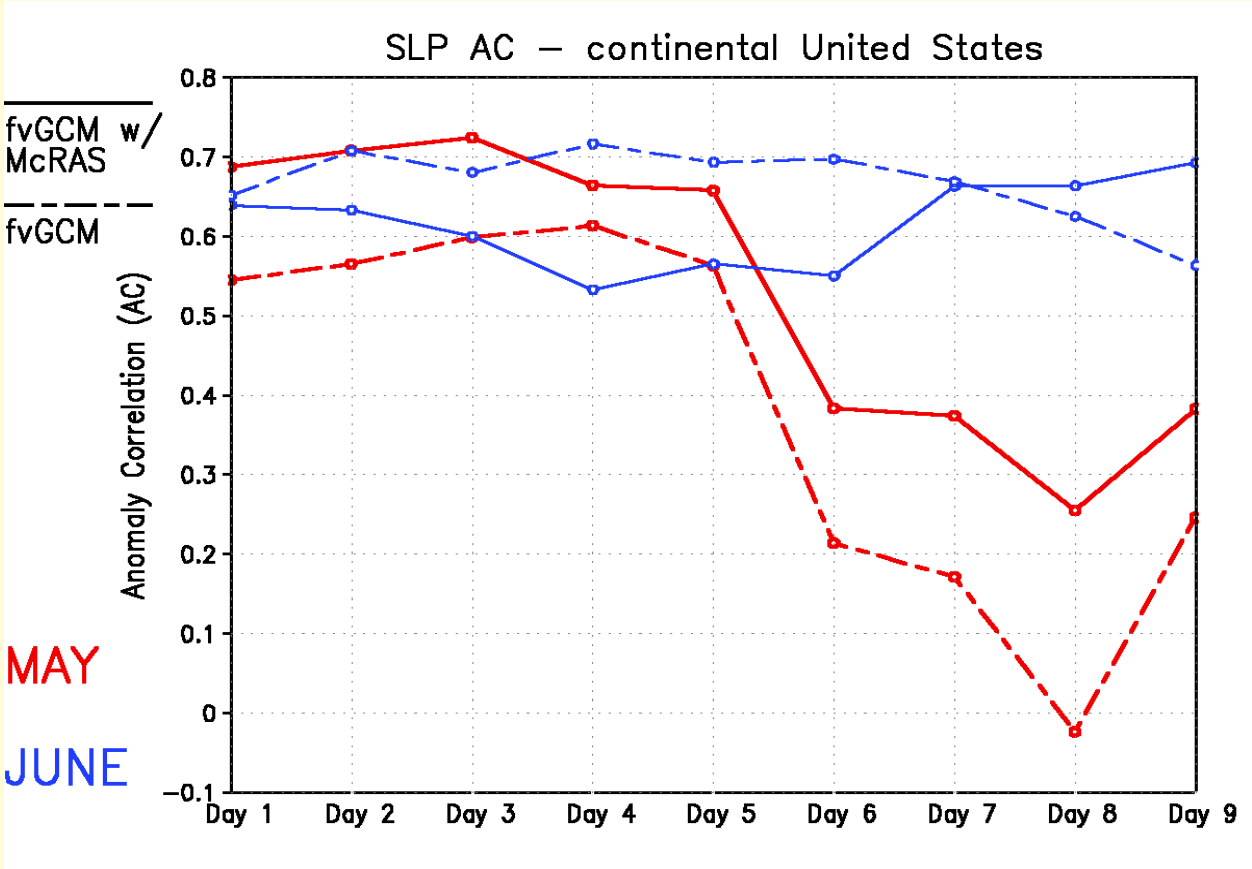
i,j represents each continental U.S. point

May & June Precipitation AC



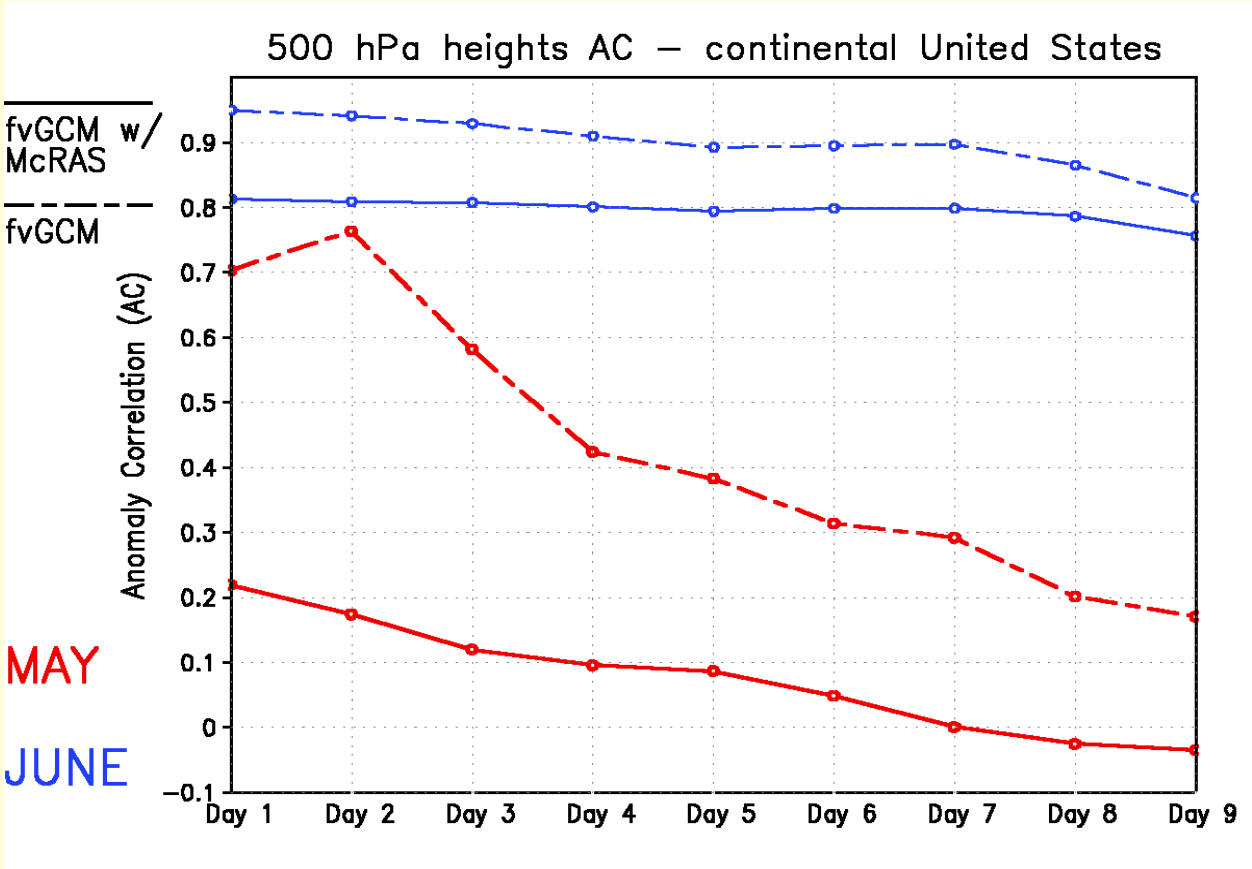
Model climatology from 17-year 1x1.25 run; Observed climatology from GPCP; 2003 observations from CPC

May & June SLP AC



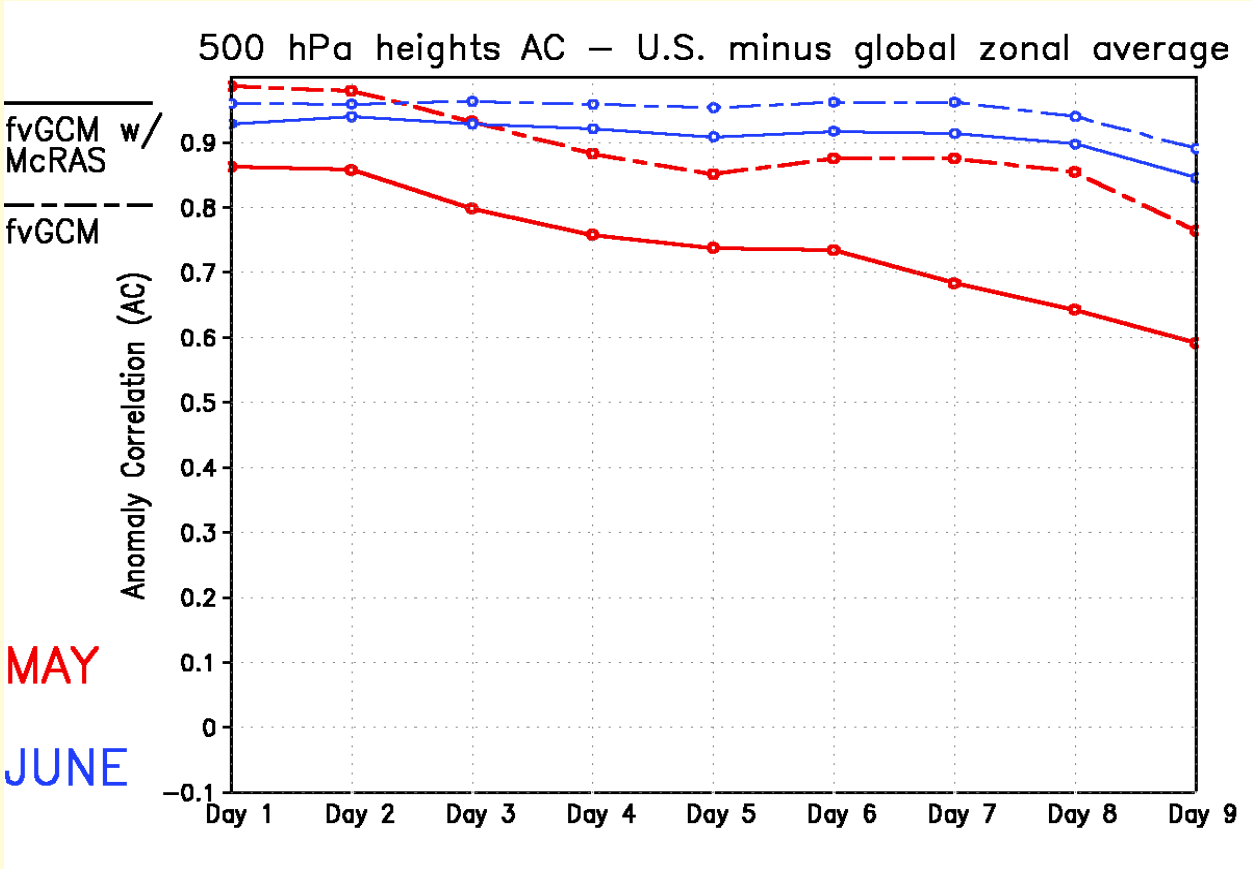
Model climatology from 17-year 1x1.25 run;
2003 observed & climatology from Goddard reanalysis

May & June 500hPa Heights AC



Model climatology from 17-year 1x1.25 run;
2003 observed & climatology from Goddard reanalysis

500hPa Heights AC w/o zonal averages



Model climatology from 17-year 1x1.25 run;
2003 observed & climatology from Goddard reanalysis

Conclusions

1. McRAS was successfully evaluated in a forecast mode in the fvGCM
2. The McRAS cloud liquid water scheme improved the simulation of precipitation in forecasts for May and June 2003
3. Further tuning of McRAS as coupled to cloud-radiation parameters needed
4. This methodology will be used to evaluate future upgrades to McRAS & other physics